REMARKS

The specification has been amended herein at paragraph [0039] to insert the issued US patent number of the Parthasarathy et al. patent that is incorporated by reference therein. Paragraph [0039] has also been amended at line 6 to correct a clerical error. The correction brings line 6 of paragraph [0039] into conformity with line 8 of paragraph [0039]. No new matter has been added.

Claims 1 - 25 and 41 have been amended to correct an informality. Claims 1-41 are currently pending.

Claim Objections

Claims 1-23 and 25-41 stand objected to based on an informality that the preamble is directed to a cathode, but the elements of the claim include limitations directed to parts of a device other than a cathode. The Applicants note that element (c) of claim 24 may have a similar issue.

Claims 1-25 and 41 have been amended to correct the informality. No new subject matter has been added. With respect to dependent claims 26-40, the Applicants respectfully assert that the amendment to independent claim 25 addresses the issue. Reconsideration and withdrawal of the objection is requested.

Claim Rejections - Claims 1, 3, 5, 7, 8, 11, 14 and 17-22

Claims 1, 3, 5, 7, 8, 11, 14, and 17-22 stand rejected as obvious under 35 USC 103(a) in view of Wakimoto '635, Guha '545, and a Raychaudhuri article. The Applicants respectfully traverse this rejection.

Claim 1 requires a device structure that includes the following layers, disposed in the

following order, over the organic operative layer of an opto-electronic device:

(1) an electron injection layer

(2) an organic buffer layer

(3) a conducting layer

(4) a transparent conductive oxide layer

As indicated in the specification at paras. 78-79, the applicants have found that this specific combination of layers has particularly favorable properties. Without intending to be limited as to invention works, it is believed that the favorable properties may occur because the deposition of the transparent conductive oxide alters the underlying conducting and organic buffer layers (specification, para. 79).

None of the art used to reject claim 1 discloses or suggests the unique combination taught by the applicants, nor suggests this combination and its particularly favorable properties. Rather, it took three different references to even disclose all of the layers taught by the applicants. Specifically:

- Guha '545 is cited as disclosing layers (3) and (4)
- Wakimoto is cited as disclosing layers (1) and (3)
- Raychaudhuri is cited as disclosing layers (2) and (3), where layer (3) is sputter deposited.

The Applicants respectfully traverse this rejection because the suggested motivation to combine is improper. Specifically, the suggested motivation that one of skill in the art would incorporate the buffer of Raychaudhuri into a conglomerate of Guha '545 and Wakimoto '635 "to protect the organic layers" is improper. In fact, Guha '545 teaches away from the suggested motivation to combine.

Raychaudhuri is cited as teaching "a layer of CuPc over the electron transport layer [that] protects the organic layers from being damaged during sputter deposition of the

cathode" Office Action, page 3. But Guha '545, the only reference cited to reject claim 1 that discloses the transparent conductive oxide layer required by the claims, teaches that a "damage free deposition process" is needed for the transparent conductive oxide. Guha '545, col. 3, lines 55-67. In addition, Guha '545 teaches that a ZnSe layer can be used to protect underlying layers from damage during the deposition of a transparent conductive oxide. *Id.* One of skill in the art would therefore *not* be motivated to add the CuPc layer of Raychaudhuri to the transparent oxide layer of Guha '545 in order "to protect the organic layers" (Office Action, page 3), because Guha '545 *already has* a mechanism for protecting the underlying organic layers -- the ZnSe layer.

Moreover, Guha '545 teaches away from the suggested combination. In addition to a "Damage Free Deposition Process," Guha '545 teaches that "High Parallel and Perpendicular Conductivity" is a requirement of the device in question. Guha '545, col. 4, lines 14-15. With respect to perpendicular conductivity, Guha '545 teaches that the ZnSe film "is conducting in a direction perpendicular to the film surface" and that the series resistance of such a film in an OLED stack would be "negligible." Guha '545, col. 4, lines 22-31. There is no teaching in the prior art that the organic buffer layer in of the present invention would not add resistance or would only add "negligible" resistance. Indeed, it is a part of the teaching of the present application that one might expect an organic buffer layer to increase operating voltage (i.e., resistance), specification, para. 29.

The present application further teaches that an expected increase in resistance due to the buffer layer may be mitigated because depositing a conductive oxide over a conductive layer, a buffer layer, and an injection layer may lead to favorable modifications of those layers, thus lowering the operating voltage. specification, para. 79. It would be impermissible hindsight to use the applicant's insight to motivate a combination of the prior art. Without this insight, one of skill in the art would expect that the suggested combination

of adding the CuPc layer of Raychaudhuri to the structure of Guha '575 to significantly increase operating voltage. Even if the CuPc layer of Raychaudhuri were substituted for the ZnSe layer of Guha '545 (and such a substitution is not suggested or taught anywhere), one of skill in the art would still expect the operating voltage to increase, and would therefore be taught away from making such a substitution by Guha's teaching that a high perpendicular conductivity is a requirement.

Claims 3, 5, 7, 8, 11, 14 and 17-22 are each ultimately dependent upon claim 1, and are patentable for at least the same reasons. The Applicants silence with respect to the specific grounds for rejection of these claims does not indicate acquiesence.

RESPONSE TO ARGUMENTS re: Wakimoto, Guha and Raychaudhuri

The arguments above re: claims 1, 3, 5, 7, 8, 11, 14 and 17-22 have been previously made. In the office action of July 9, 2004, at page 27, the examiner indicated that Applicants argument that Wakimoto, Guha and Raychaudhuri was unconvincing because "Although the reference of Guha teaches the ITO layer in conjunction with the ZnSe layer, there is nothing in the claim to preclude having two buffer layers." The Applicants fail to understand how this assertion has any bearing as to whether Guha and Raychaudhuri may be properly combined, because the references do not teach or suggest a device having two buffer layers, and in fact teach away from such a device.

Specifically, the Applicant argues that one of skill in the art would not substitute the CuPc protective layer of Raychaudhuri for the ZnSe layer of Guha, because Guha teaches that the perpendicular conductivity of ZnSe is important, and, without the benefit of the present invention, one of skill in the art would expect CuPc to have poor perpendicular conductivity one of skill in the art. This same rationale applies to the *addition* of the CuPc protective layer of Raychaudhuri to the ZnSe layer of Guha. Adding CuPc to the ZnSe serves no purpose,

because the ZnSe already protects the underlying layers, and all the CuPc would be expected to do is increase operating voltage, contrary to what Guha teaches is desirable. Thus, one of skill in the art contemplating the suggested combination would not have a reasonable expectation of success, i.e., a device with a reasonable operating voltage.

The claims require the following layers:

(1) an electron injection layer

(2) an organic buffer layer

(3) a conducting layer

(4) a transparent conductive oxide layer

The prior art fails to teach or suggest this unique combination of elements in which an electron injection layer is disposed between an organic buffer layer and an underlying operative layer in an optoelectronic device and, in addition, a conductive layer is disposed between the organic buffer layer and an overlying transparent conductive oxide layer. As indicated in the specification at paras. 78-79, the applicants have found that this specific combination of layers has particularly favorable properties and overcomes many of the drawbacks associated with transparent top electrodes in the prior art. The conducting layer and the electron injecting layer, disposed over and under the buffer layer respectively, are thin enough to retain transparency. The experimental results indicate that the intervening buffer layer is thick enough to prevent damage to the organic operative layer during sputtering of a suitably transparent top electrode material, yet the operating voltage is not significantly increased. It is believed that improved electron injection in the devices of the present invention leads to a better balance of carriers which improves lifetime and unexpectedly lowers operating voltage.

Regardless of whether the claims preclude two buffer layers, nothing in the art cited by the examiner teaches the suggested combination (whether there are one or two buffer

layers), and Guha teaches away. It would be impermissible hindsight to rely on the Applicants' disclosure to motivate the combination. The Applicants respectfully assert that the "response to arguments" does not refute Applicants' argument.

Claim Rejections - Claims 1, 7, 14, 17-22, 25, 31, 38 and 41

Claims 1, 7, 14, 17-22, 25, 31, 38 and 41 stand rejected as obvious under 35 USC 103(a) over the Raychaudhuri article in view of Forrest 6,548,956. The Applicants respectfully traverse this rejection.

Raychaudhuri et al is cited as teaching an organic EL device with a cathode made of Al:Li, an organic EL layer, a buffer layer made of CuPc and an electron injection layer, but not a conductive oxide layer. Forrest '956 is cited as disclosing a conductive oxide on top of the cathode to reduce resistivity. Applicants respectfully traverse this rejection and maintain that there is no motivation to make the suggested combination, and that a prima facie case of obviousness has not been made.

According to the office action, Raychaudhuri et al teaches, at columns 1 and 2, an EL device with Al:Li cathode, an organic EL layer, a buffer layer made of CuPc and an electron injection layer but fails to teach ITO on top of the cathode. According to the office action, it would have been obvious to incorporate a conductive oxide layer on top of the cathode "to reduce resistivity" as taught by Forrest. A partial teaching has been extracted to support the rejection while failing to consider what the references as a whole fairly suggest. Forrest does not merely teach incorporating a conductive oxide layer on top of the cathode "to reduce resistivity" as suggested in an attempt to reconstruct present claim 1. Forrest teaches the use of a top layer of ITO in a transparent cathode structure to reduce resistivity "while retaining acceptable transparency." (See col. 19, lines 6-7).

One skilled in the art would not be motivated to modify the cathode cited in

Raychaudhuri et al. by additionally depositing a layer of ITO as suggested. The references are directed to two different types of cathodes - transparent and non-transparent. The top ITO layer taught in Forrest et al is incorporated into a transparent electrode structure. The Al:Li cathode cited from Raychaudhuri to make this rejection is a non-transparent cathode. See Raychaudhuri at 526, describing the Raychaudhuri cathodes as being for "OLEDs." Where Raychaudhuri describes a top-emitting device with a transparent cathode, he takes care to describe the device as a "TOLED" (top-emitting OLED) at the bottom of p. 526, col. 1. In addition, the devices of Raychaudhuri are compared to devices having a 220 nm thick Mg:Ag cathode, which is not transparent. See Raychaudhuri, Table 1; see also, US Patent 4,769,292 to Tang, col. 5, lines 39-45 (describing 50 - 250 angstroms, i.e., 0.5 to 25 nm, as thicknesses for transparent metal cathodes, and the use of thicker cathodes "where the electrode is not intended to transmit light"; col. 45, lines 3-5, describing a 200 nm Mg:Ag cathode); Forrest 6,548,956, col. 62, line 62 (teaching 5-40 nm thick metal as transparent). One of skill in the art would not be motivated to deposit a transparent conductive oxide such as ITO over the 100 nm thick non-transparent Li:Al cathode example cited in Raychaudhuri et al.

Raychaudhuri discloses a 100-200 nm thick top Li:Al electrode (cathode) deposited directly over CuPc in a conventional bottom emitting device (an OLED that emits light only through a transparent bottom electrode *e.g.* the anode). The 100 nm thick Li:Al cathode cited by the office action is not transparent and is useful in devices where top emission is not required. Forrest, on the other hand, teaches a thin metal conducting layer only 5-40 nm thick over which a transparent layer of ITO is deposited "to reduce resistivity, while retaining acceptable transparency" in devices where top emission is required (see entire disclosure, for example, col. 18, line 62; col. 19, lines 6-7 and col. 19, lines 6-7 30-50). One of skill in the art would not add a fabrication step and deposit a transparent conductive oxide over the non-transparent cathode of a bottom emitting device such as that cited in Raychaudhuri et al..

Rather, if increased conductivity were desired, it would be much simpler to increase the thickness of the Li:Al cathode, and avoid all of the issues associated with sputter-deposited ITO. At col. 6, lines 21-27, Forrest teaches that devices have one type of top electrode or the other - either a thin metal/ITO transparent electrode or a thick metal non-transparent electrode- not a combination of both:

> In the embodiments of the invention, relative to FIGS. 2A and 2B, the top ITO contact 26I for LED 22 is transparent, making the three color device shown useful for headup display applications. However, in another embodiment of the invention, the top contact 26I is formed from a thick metal, such as either Mg/Ag, In, Ag, or Au, for reflecting light emitted upward back through substrate 13, for substantially increasing the efficiency of the device.

The Federal Circuit has held that the mere fact that references can be combined does not cause the resulting combination to be obvious absent the prior art suggesting the combination. ACS Hospitals Inc. v. Montefiore Hospital, 732 F2d 1572, 221 USPQ 929,933 (Fed. Cir. 1984). In making such a combination, "there must be some reason for the combination other than the hindsight gleaned from the invention itself." Interconnect Planning Corp. v. Feil, 774, F2d 1132, 227 USPQ 543, 551 (Fed Cir. 1985). Because of the tradeoff between transparency and efficiency taught by Forrest above, one skilled in the art would not be motivated to substitute Forrest's transparent thin metal/ITO electrode for the 100 nm thick Al:Li cathode Raychaudhuri's non-transparent example.

Due to the disparity between Applicants' invention and the teachings of these references, it is respectfully submitted that one of ordinary skill in the art would never be motivated to combine the teachings of these references as the Examiner has done in making this rejection. Rather, Applicants' disclosure has provided motivation for the attempt to combine these references. One of ordinary skill in the art would not be motivated to combine the references except by the application of hindsight based on the present claims.

Claim Rejections - Claims 1, 3, 5, 7, 8, 11, 14, and 17-22

Claims 1, 3, 5, 7, 8, 11, 14, and 17-22 stand rejected under 35 USC 103(a) as unpatentable over Wakimoto ('635) in view of Forrest et al. ('956) in further view of the Raychaudhuri article. The Applicants respectfully traverse this rejection.

Wakimoto is cited as disclosing a device having at least one transparent electrode. Wakimoto is also cited as disclosing "a cathode with a hole injecting layer (Figure 3, Element 6b), an organic layer (Figure 3, Elements 5 and 3), and a conducting layer (Figure 3, Element 1). Forrest is cited as teaching the addition of ITO over a cathode to reduce resistivity. Raychaudhuri is cited as teaching a buffer layer to protect from ITO sputter damage.

While Wakimoto does mention that "at least one of the electrodes 1 and 2 may be transparent," all of the Figures of Wakimoto illustrate downward emission. Neither does Wakimoto specifically teach how to achieve a top-emitting device. As a result, Wakimoto and Raychuadhuri combined suffer from the same deficiency as Raychaudhuri discussed above -- one of skill in the art would merely increase the thickness of the top electrode to increase conductivity, rather than introducing the problems associated with extra different layers, and the issues involved with sputter-deposited ITO. A prima-facie case of obviousness has therefore not been made.

UNEXPECTED RESULTS

In any event, even if a prima-facie case of obviousness has been made based on any of the combinations discussed above, the Applicants have shown unexpected results from the specific combination of layers claimed. Specifically, in the specification at pages 22-27, devices in accordance with the invention were fabricated and compared to various prior art devices. It was found that the claimed devices had unexpectedly higher current densities and lifetimes than prior art devices. For example, comparing the claimed device to a similar device without an ITO layer, it was found that the operating voltage was *lower* when the ITO

was added, even though the addition of a layer on top of a device would generally be expected to *increase* operating voltage due to interfacial and bulk resistance effects, no matter how conductive the layer. The inventors believe that these superior results are due to deposition of a conductive oxide knocking conductive material into the buffer layer, improving electron injection. See para. 79. There is no hint or suggestion in the references used to piece together a rejection of the claims that there would be this unexpected synergy between the four layers (injection layer, buffer layer, conducting layer and transparent conductive oxide). The Applicants respectfully assert that if a prima facie rejection has been made, that the rejection has been overcome by these unexpected results.

Included with this response is a declaration of inventor Michael Lu describing the unexpected nature of the results.

DEPENDENT CLAIMS

The following arguments apply to dependent claims that have been rejected based on:

(1) Wakimoto, Guha and Raychaudhuri;

(2) Raychaudhuri and Forrest; and

(3) Wakimoto, Forrest and Raychaudhuri

Where the arguments refer to "the references used to reject claim 1," they are referring to each of these three combinations.

Claim 2

Claim 2 stands rejected as obvious in view of the references used to reject claim 1, in further view of Jones '033. Jones '033 is cited as disclosing an injection layer of LiF on Al. This does not impact the above arguments relating to claim 1.

Claim 2 is ultimately dependent upon claim 1, and is patentable for at least the same

reasons. The Applicants silence with respect to the specific grounds for rejection of this claim does not indicate acquiesence.

Claims 4 and 6

Claims 4 and 6 stand rejected as obvious in view of the references used to reject claim 1, in further view of Tanaka '734. Tanaka '734 is cited as disclosing an injection layer of alkali metal, alkali earth metal, and rare earth metal. This does not impact the above arguments relating to claim 1.

Claims 4 and 6 are ultimately dependent upon claim 1, and are patentable for at least the same reasons. The Applicants silence with respect to the specific grounds for rejection of these claims does not indicate acquiesence.

Claim 9

Claim 9 stands rejected as obvious in view of the references used to reject claim 1, in further view of a Parthasarathy article. Parthasarathy is cited as disclosing the use of BCP instead of CuPc as a buffer layer. This does not impact the above arguments relating to claim 1.

Claim 9 is ultimately dependent upon claim 1, and is patentable for at least the same reasons. The Applicants silence with respect to the specific grounds for rejection of this claim does not indicate acquiesence.

Claim 12

Claim 12 stands rejected as obvious in view of the references used to reject claim 1, in further view of Haight '838. Haight '838 is cited as disclosing a thin layer of Ca beneath an ITO layer. This does not impact the above arguments relating to claim 1.

Claim 12 is ultimately dependent upon claim 1, and is patentable for at least the same reasons. The Applicants silence with respect to the specific grounds for rejection of this claim does not indicate acquiesence.

Claim 13

Claim 13 stands rejected as obvious in view of the references used to reject claim 1, in further view of Raychaudhuri '752. Raychaudhuri '752 is cited as disclosing an LiF/Al contact. This does not impact the above arguments relating to claim 1.

Claim 13 is ultimately dependent upon claim 1, and is patentable for at least the same reasons. The Applicants silence with respect to the specific grounds for rejection of this claim does not indicate acquiesence.

Claims 15 and 16

Claims 15 and 16 stand rejected as obvious in view of the references used to reject claim 1, in further view of Beck '364. Beck '364 is cited as disclosing that specific oxides are interchangeable. This does not impact the above arguments relating to claim 1.

Claims 15 and 16 are ultimately dependent upon claim 1, and is patentable for at least the same reasons. The Applicants silence with respect to the specific grounds for rejection of this claim does not indicate acquiesence.

Claim 23

Claim 23 stands rejected as obvious in view of the references used to reject claim 1, in further view of Jones '033. Jones '033 is cited as disclosing an LiF/Al contact. This does not impact the above arguments relating to claim 1.

Claim 23 is an independent claim, but it essentially includes all of the limitations of

claim 1. Specifically, claim 23 claims an example, with specific materials, of the structure of claim 1. The arguments and combination of references used to reject claim 23 is the same as that used to reject claim 1, with the addition of Jones '033. The arguments that applicants made above with respect to claim 1 apply with equal force to claim 23, so claim 23 is patentable for at least the same reasons as claim 1. The Applicants silence with respect to the further specific arguments made regarding claim 23 does not indicate acquiesence.

Claim 24

Claim 24 stands rejected as obvious in view of the references used to reject claim 1.

Claim 24 is an independent claim, but it essentially includes all of the limitations of claim 1. Specifically, claim 24 is directed to an entire device that includes the cathode of claim 1. The arguments and combination of references used to reject claim 24 is the same as that used to reject claim 1. The arguments that applicants made above with respect to claim 1 apply with equal force to claim 24, so claim 24 is patentable for at least the same reasons as claim 1. The Applicants silence with respect to any further specific arguments made regarding claim 24 does not indicate acquiesence.

Claims 25, 27, 29, 31, 32, 35, 38 and 41

Claims 25, 27, 29, 31, 32, 35, 38 and 41 stand rejected for reasons analogous to those use to reject claims 1, 3, 5, 7, 8, 11, 14 and 22, respectively. The Applicants' arguments regarding claims 1, 3, 5, 7, 8, 11, 14 and 22 apply with equal force to claims 25, 27, 29, 31, 32, 35, 38 and 41. The Applicants respectfully request reconsideration and withdrawal of this rejection based on those arguments.

Claim 26

Claim 26 stands rejected for reasons analogous to those used to reject claim 2. The Applicants' arguments regarding claim 2 applies with equal force to claim 26. The Applicants respectfully request reconsideration and withdrawal of this rejection based on those arguments.

Claims 28 and 30

Claims 28 and 30 stand rejected for reasons analogous to those used to reject claims 4 and 6. The Applicants' arguments regarding claims 4 and 6 apply with equal force to claims 28 and 30. The Applicants respectfully request reconsideration and withdrawal of this rejection based on those arguments.

Claim 33

Claim 33 stands rejected for reasons analogous to those used to reject claim 9. The Applicants' arguments regarding claim 9 apply with equal force to claim 33. The Applicants respectfully request reconsideration and withdrawal of this rejection based on those arguments.

Claim 36

Claim 36 stands rejected for reasons analogous to those used to reject claim 12. The Applicants' arguments regarding claim 12 apply with equal force to claim 36. The Applicants respectfully request reconsideration and withdrawal of this rejection based on those arguments.

Claim 37

Claim 37 stands rejected for reasons analogous to those used to reject claim 13. The Applicants' arguments regarding claim 13 apply with equal force to claim 37. The Applicants respectfully request reconsideration and withdrawal of this rejection based on those arguments.

Claims 39 and 40

Claims 39 and 40 stand rejected for reasons analogous to those used to reject claims 15 and 16. The Applicants' arguments regarding claim 15 and 16 apply with equal force to claims 39 and 40. The Applicants respectfully request reconsideration and withdrawal of this rejection based on those arguments.

Claims 10 and 34

Claims 10 and 34 stand objected to as dependent on a rejected base claim, but allowable if rewritten in independent form.

The Applicants respectfully traverse this objection, based on the arguments above that the base claims are allowable. Applicants request reconsideration and withdrawal of this rejection.

CONCLUSION

In view of the remarks herein, reconsideration and withdrawal of all pending rejections is respectfully requested. The Office is authorized to charge any additional fees or credit any overpayments under 37 C.F.R. § 1.16 or 1.17 to Deposit Account No. 11-0600.

Respectfully submitted,

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